Attorney's Docket No. 5649-1277 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Kwang-hee Lee et al. Examiner: Thanh Y. Tran
Serial No.: 10/801,208 Group Art Unit: 2822
Filed: March 16, 2004 Confirmation No.: 2034
For: METHODS OF MANUFACTURING SEMICONDUCTOR DEVICES HAVING A RUTHENIUM LAYER VIA AUTOMATIC LAYER DEPOSITION

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January 3, 2008

APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. § 41.37

Sir:

This *Appeal Brief* is filed pursuant to the *Notice of Appeal* filed concurrently herewith. This Appeal Brief is filed in response to th *Final Office Action* ("*Final Action*") mailed October 9, 2007.

It is not believed that an extension of time and/or additional fee(s) are required, beyond those that may otherwise be provided for in documents accompanying this paper. In the event, however, that an extension of time is necessary to allow consideration of this paper, such an extension is hereby petitioned under 37 C.F.R. § 1.136(a). Any additional fees believed to be due may be charged to Deposit Account No. 50-0220.

Real Party In Interest

The real party in interest is assignee Samsung Electronics Co., Ltd of Gyeonggi-do, Republic of Korea.

Related Appeals and Interferences

Appellants are aware of no appeals or interferences that would be affected by the present appeal.

Status of Claims

Claims 1-47 have been presented during the prosecution of the present application. Claims 1 and 15-33 have been cancelled. Accordingly, Claims 2-14 and 34-47 remain pending. Of the pending claims, Claims 4-8, 14, 34-45 and 47 are allowed. Claims 2-3, 9-13 and 46 each stand finally rejected. Appellants appeal the final rejection of Claims 2-3 and 9-13. Appellants are **not** appealing the rejection of Claim 46 because Appellants intended to

cancel Claim 46 earlier in the prosecution. The attached Claims Appendix presents the claims that are on appeal as they currently stand following entry of Appellants' *Amendment* of July 12, 2007.

Status of Amendments

As filed, the present application included Claims 1-33. In response to the *Restriction and Election Requirement* of December 14, 2005, Appellants filed a *Preliminary Amendment and Response to Restriction Requirement* on January 3, 2006, in which Claims 27-33 were cancelled without prejudice, and Claims 15-25 were withdrawn from consideration. An *Office Action* was mailed on March 17, 2006. Appellants filed a *Response* in order to address the rejections in this *Office Action* on June 5, 2006. This *Response* did not include any claim amendments, and was entered.

A *Final Office Action* was issued on August 16, 2006. In response thereto, Appellants filed a *Notice of Appeal* and a *Pre-Appeal Request for Review* on October 2, 2006. On February 1, 2007, a *Notice of Panel Decision* was received which reopened prosecution of this case.

A non-final *Office Action* was then issued on April 18, 2007. In response thereto, Appellants filed an *Amendment* on July 12, 2007 which cancelled Claims 1 and 15-25, amended Claims 4-10 and 13-14 and added new Claims 34-47. This *Amendment* was entered. The *Final Office Action* from which the present appeal is being taken was issued on October 9, 2007.

Summary of Claimed Subject Matter

As noted above, the present appeal involves Claims 2-3 and 9-13. Of these claims, Claim 13 is the only independent claim.

Claim 13 is directed to a method of fabricating an electrode for a microelectronic device. Pursuant to the method of Claim 13, a ruthenium seed layer such as ruthenium seed layer **140** of **Fig. 2B** is formed using atomic layer deposition on a semiconductor substrate such as semiconductor substrate **100** of **Fig. 2B**. (*See* Application at page 6, line 23 through page 7, line 8 and **Fig. 2B**). Then, a main ruthenium layer such as, for example, main ruthenium layer **145** of **Fig. 2B** is formed on the ruthenium seed layer **140**. (*See* Application at page 7, lines 9-18 and **Fig. 2B**). Next, the main ruthenium layer **145** and the ruthenium seed layer **140** may be patterned to form the electrode **150**. (*See* Application at page 7, lines

19-23 and **Fig. 2C**). The main ruthenium layer **145** may be formed using chemical vapor deposition. (*See* Application at page 7, lines 9-18).

Grounds of Rejection to be Reviewed on Appeal

Appellants appeal the rejections of Claims 2-3 and 9-13 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2003/0017669 to Kiyotoshi et al. ("Kiyotoshi") in view of U.S. Patent No. 6,756,261 to Hong ("Hong") and U.S. Patent No. 6,656,784 to Pakr ("Pakr").

Argument

Appellants sincerely appreciate the allowance of Claims 4-8, 14, 34-45 and 47. Appellants hereby appeal the rejections of Claims 2-3 and 9-13, which Appellants respectfully submit are patentable over the cited art for the reasons discussed below.

I. The Rejections of Claims 2-3, 9-10 and 13 Should be Reversed

Independent Claim 13 and Claims 2-3 and 9-10 depending therefrom each stand finally rejected under 35 U.S.C. § 102(b) as being unpatentable over Kiyotoshi in view of Hong and Pakr. (*Final Action* at 2-4). Appellants respectfully request reversal of each of these rejections.

Independent Claim 13 recites:

> 13. A method of fabricating an electrode for a microelectronic device, the method comprising:
>
> forming a ruthenium seed layer using atomic layer deposition on a semiconductor substrate;
>
> forming a main ruthenium layer on the ruthenium seed layer; and
>
> patterning the main ruthenium layer and the ruthenium seed layer to form the electrode;
>
> wherein the main ruthenium layer is formed using chemical vapor deposition.

The *Final Action* states that Kiyotoshi at Figs. 9A-9D and the discussion thereof discloses all of the recitations of Claim 13 except for (1) the ruthenium seed layer being formed by atomic layer deposition and (2) the main ruthenium layer being formed by chemical vapor deposition. (*Final Actio*n at 2-3). The *Final Action* further states that Hong at Col. 3, lines 28-33 discloses forming a ruthenium layer by atomic deposition, and that Pakr at Col. 5, lines 15-20 discloses forming a main ruthenium layer by chemical vapor deposition. (*Final Action*

at 2-3). The Final Action also asserts that it would have been obvious to modify Kiyotishi to use the atomic layer deposition as taught by Hong "for controlling the composition easily with excellent step coverage", and that it would have been obvious to modify this combination of Kiyotoshi and Hong to use the chemical vapor deposition approach of Pakr to "produc[e] [a] high quality depositing layer." (*Final Action* at 2-3). Appellants respectfully submit that the rejection of Claim 13 should be reversed for at least five (5) reasons.

First, Appellants respectfully submit that the prior art does not fairly teach or suggest modifying the method of Kiyotoshi so that atomic layer deposition is used instead of sputtering to form the seed layer. The *Final Action* states that one of skill in the art would have been motivated to modify the method of Kiyotoshi to form the ruthenium seed layer using the atomic layer deposition process discussed in Hong because Hong teaches that this will allow "controlling the composition easily with excellent step coverage." (*See Final Action* at 2, citing to Col. 33, line 28-33 of Hong). However, the cited portion of Hong is actually **discussing the formation of an STO layer as opposed to a ruthenium seed layer**. Specifically, the cited portion of Hong states that **after** the bottom electrode is formed of a noble metal such as Pt, Ru or Ir, "an STO layer is formed at a thickness ranging from 5 nm to 10 nm using the atomic layer deposition process which can control the composition easily with excellent step coverage." (Hong at Col. 3, lines 28-33). The fact that Hong is referring to the formation of the STO layer, as opposed to the noble metal bottom electrode, is confirmed by the discussion in the Detailed Description of Hong, which describes in detail how the composition of the STO layer may be easily controlled. (*See* Hong at Col. 4, lines 51-65; *see also* Hong at Abstract, stating that Hong is directed to a "method for fabricating a capacitor of a semiconductor device . . . which can **control the composition of a dielectric layer easily**"). Thus, Appellants respectfully submit that the cited portion of Hong at most suggests that forming an STO dielectric layer using atomic layer deposition may facilitate control of the composition of such a dielectric layer, and clearly does not suggest any modification to the ruthenium layer formation steps of Kiyotoshi.

Second, Appellants respectfully submit that one of skill in the art would not have had any reason to combine the identified features of the methods of Kiyotoshi and Hong that are relied upon in the pending rejections. The "invention" of Kiyotoshi is directed to "a technology of forming an electrode using an electroplating method." (*See, e.g.*, Kiyotoshi at ¶ 0003). In contrast, as noted above, Hong is directed to a "method for fabricating a capacitor

of a semiconductor device . . . which can control the composition of a dielectric layer easily." (*See* Hong at Abstract). Hong's discussion regarding the formation of a ruthenium lower electrode is essentially limited to (1) the statement at Col. 3, lines 28-30 that "after a bottom electrode of a capacitor with a noble metal, such as Pt, Ru or Ir and STO layer is formed . . . using atomic layer deposition " and (2) the statement at Col. 4, lines 47-50 that "a bottom electrode 26 is deposited by using such a noble metal as Pt, Ru, Ir or SRO ($SrRuO_3$), or an oxide conductive material like RuO_2 or IrO_2." Thus, it is clear that the purported invention of Hong involves the STO dielectric layer as opposed to the bottom electrode. As such, there is simply no reason to modify a portion of the electrode fabrication steps of Kiyotoshi to include the atomic layer deposition technique of Hong as suggested in the pending rejections. *See KSR Int'l v. Teleflex Inc.*, 550 U.S. at ___ (2007), slip opinion at 14 (stating that often "it will be necessary for a court to . . . determine whether there was an apparent reason to combine . . . known elements in the fashion claimed by the patent at issue). In fact, the only possible reason that one of skill in the art would look to modify the method of Kiyotoshi to incorporate the above-quoted two sentences of Hong is by using Appellants disclosure as a road map and then picking and choosing bits and pieces of selected references to arrive at the invention of Claim 13. This, however, is not a proper basis for combining references in a rejection under 35 U.S.C. § 103, providing a second basis for reversal of the rejection of Claim 13. *See KSR Int'l v. Teleflex Inc.*, 550 U.S. at ___ (2007), slip opinion at 17.

Third, were one of skill in the art to modify the method of Kiyotoshi based on Hong, they would not do so in the manner suggested in the pending rejections. In particular, Hong teaches forming the lower electrode of a capacitor as a **single** ruthenium layer (which thus, by definition, corresponds to a **main** ruthenium layer). (*See, e.g.*, Hong at Figs. 1C-1F and Col. 4, lines 47-50). The *Final Action* does not even attempt to explain why one of skill in the art would use the technique that Hong uses for forming what constitutes **a main ruthenium layer** to modify how the ruthenium **seed layer** of Kiyotoshi is formed. Appellants respectfully submit that this is because were one of skill in the art to combine Hong's purported teachings regarding the formation of ruthenium layers by atomic layer deposition into Kiyotoshi they would do so by modifying the method of Kiyotoshi to form the **main** ruthenium layer of Kiyotoshi by atomic layer deposition. Of course, such a modification **teaches directly away** from the method of Claim 13, which requires formation of the main ruthenium layer by chemical vapor deposition. Such teaching away suggests that the

combination of references is non-obvious. *See KSR Int'l v. Teleflex Inc.*, 550 U.S. at ___ (2007), slip opinion at 12.

Fourth, Appellants also submit that the rejection of Claim 13 should be reversed because one of skill in the art would not have further modified the alleged combination of Kiyotoshi and Hong to use chemical vapor deposition as discussed in Pakr. In particular, Pakr, similar to Hong, describes the use of chemical vapor deposition to form a ruthenium layer. While the Final Action states that one of skill in the art would have been motivated to replace the electroplating technique that Kiyotoshi uses to form the main ruthenium layer with the chemical vapor deposition technique of Pakr in order to "produc[e] high quality depositing layers", none of the cited references provide any indication that this change to chemical vapor deposition would provide such an effect. Moreover, the purported invention of Pakr is directed to solving the problem of etching solutions attacking an interlayer dielectric layer as opposed to formation of improved main ruthenium layers. (*See, e.g.*, Pakr at Col. 2, lines 64-67). In any event, Appellants respectfully submit that the only possible reason that one of skill in the art would look to modify the method of Kiyotoshi to incorporate the chemical vapor deposition of Pakr is by using Appellants disclosure as a road map and then picking and choosing bits and pieces of selected references to arrive at the invention of Claim 13. However, as discussed above, this is not a proper basis for combining references in a rejection under 35 U.S.C. § 103. *See KSR Int'l v. Teleflex Inc.*, 550 U.S. at ___ (2007), slip opinion at 17.

Fifth and finally, the rejection of Claim 13 should be reversed because **Kiyotoshi teaches that the main ruthenium layer should be formed using electroplating as opposed to chemical vapor deposition**. Thus, Kiyotoshi **teaches away from using chemical vapor deposition**, and hence one of skill in the art clearly would not have been motivated to modify Kiyotoshi to use the chemical vapor deposition technique of Pakr. *See KSR Int'l v. Teleflex Inc.*, 550 U.S. at ___ (2007), slip opinion at 12. In particular, Kiyotoshi states:

> **Electroplating has been employed** as the new noble metal forming method **instead of** normal PVD or **CVD methods**. **Electroplating has the following merits**. That is, the process temperature is low (usually the same as room temperature), and in the case of making a selective growth by electroplating, it is almost no necessary to pattern the noble metal. Further, the electroplating is not a vacuum process; therefore it is instrumentally easy to prevent metal contamination on the backside of the substrate, the process cost is low, and further, the apparatus can be made compact.

(Kiyotoshi at ¶ 0012). In fact, the "invention" of Kiyotoshi "relates to a technology of forming an electrode using an electroplating method." (Kiyotoshi at ¶ 0003). Appellants respectfully submit that one of skill in the art reading Kiyotoshi and Pakr would not modify Kiyotoshi to use the CVD technique of Pakr given that neither reference suggests any benefit that would be provided by such a change, and given that Kiyotoshi teaches that electroplating has numerous advantages.

Accordingly, for each of the above reasons, Appellants respectfully submit that the rejection of Claim 13 should be reversed.

Claims 2-3 and 9-10 each depend from Claim 13. Accordingly, the rejections of these claims should be reversed for at least the same reasons, discussed above, that the rejection of Claim 13 should be reversed.

II. The Rejections of Dependent Claims 11-12 Should be Reversed

Claims 11-12 depend from Claim 13. Accordingly, the rejections of these claims should be reversed for at least the same reasons, discussed above, that the rejection of Claim 13 should be reversed. Moreover, Appellants submit that the rejections of each of these claims should also be reversed for the following additional, independent reasons.

Claim 11 recites that "the dielectric layer comprises a tantalum oxide layer." The *Final Action* concedes that the cited references do not disclose a tantalum oxide dielectric layer, but argues that it would have been obvious to one of skill in the art to use such a dielectric layer. (*Final Action* at 4). Appellants respectfully submit, however, that there has been no showing that it would have been obvious to take the method of Kiyotoshi, to then modify that method to use the atomic layer deposition for one layer, further modify that method to use chemical vapor deposition for the formation of another layer, and then yet again further modify that method to replace the dielectric layer of Kiyotoshi with a tantalum oxide dielectric layer. The only reason one of skill in the art would have for making this series of changes is the disclosure of the present application. Accordingly, the rejection of Claim 11 should be reversed for this additional reason.

Claim 12 recites that forming the upper electrode comprises:

> forming a second ruthenium seed layer using atomic layer deposition on the dielectric layer; and
>
> forming a second main ruthenium layer on the second ruthenium seed layer.

The *Final Action* states that Fig. 9C of Kiyotoshi discloses the recitations of Claim 12. (*Final Action* at 5). However, Appellants respectfully submit that Fig. 9C of Kiyotoshi discloses only the formation of a first seed layer and a first main layer, and clearly does not disclose the formation of both first and second seed layers and first and second main layers. This is confirmed by the fact that the pending rejections cite to the same layers of Fig. 9C as comprising the first and second seed layers, and as comprising the first and second main layers. (*See Final Action* at 2 and 5). Accordingly, the rejection of Claim 12 should also be reversed for at least this additional reason.

III. Conclusion

For the foregoing reasons, Appellants respectfully submit that all of the claims are patentable over the cited prior art and that the pending rejections should be reversed.

Respectfully submitted,

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CERTIFICATION OF TRANSMISSION

I hereby certify that this correspondence is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4) to the U.S. Patent and Trademark Office on January 3, 2008.

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CLAIMS APPENDIX

2. The method of Claim 13, further comprising:

forming a dielectric layer on the electrode; and

forming an upper electrode on the dielectric layer to provide a capacitor.

3. The method of Claim 2, further comprising forming a storage node contact plug on the semiconductor substrate and a storage node that is electrically connected to the storage node contact plug to provide a semiconductor memory device, wherein the ruthenium seed layer is formed on the storage node contact plug.

9. The method of Claim 3, wherein the ruthenium seed layer is formed to a thickness of about 5 Å to 50 Å and wherein the main ruthenium layer is formed to a thickness of 50 Å to 300 Å.

10. The method of Claim 9, wherein the forming of the main ruthenium layer comprises supplying oxygen at a flow rate of about 1 sccm to 50 sccm and supplying a ruthenium source at a flow rate of about 0.1 ccm to 2 ccm under a pressure of about 0.4 Torr to 0.6 Torr.

11. The method of Claim 2, wherein the dielectric layer comprises a tantalum oxide layer.

12. The method of Claim 2, wherein the forming of the upper electrode comprises:

forming a second ruthenium seed layer using atomic layer deposition on the dielectric layer; and

forming a second main ruthenium layer on the second ruthenium seed layer.

13. A method of fabricating an electrode for a microelectronic device, the method comprising:

forming a ruthenium seed layer using atomic layer deposition on a semiconductor substrate;

forming a main ruthenium layer on the ruthenium seed layer; and

patterning the main ruthenium layer and the ruthenium seed layer to form the electrode;

wherein the main ruthenium layer is formed using chemical vapor deposition.

EVIDENCE APPENDIX

No evidence is being submitted with this *Appeal Brief* pursuant to 37 C.F.R. §§ 1.130, 1.131 or 1.132.

RELATED PROCEEDINGS APPENDIX

There are no related proceedings.